OIPE IAP5 SEP 06 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OIPE IAP52 SEP 08 2005 PATENT & TRADEMARK OFFICE

Serial No.:	10/628,651
Filed:	July 28, 2003
Group Art Unit:	1742
Examiner:	Sikyin Ip
Applicant:	Joseph W. Harris
Title:	PHOSPHORUS-COPPER BASE BRAZING ALLOY
Attorney Docket:	JWH-59US
Confirmation No.:	4424

FIRST AFFIDAVIT OF ROBERT HENSON UNDER 37 C.F.R. § 1.132, ¶ 1

My name is Robert Henson. I am the Technical Director of the J.W. Harris Co., and have held that position for the last ten years. I have been employed by J.W. Harris Co. for a total of twenty-seven years. In my current and past capacities with J.W. Harris Co., I have had extensive experience with brazing alloy compositions, various forms of brazing components, the use of brazing fluxes, and the brazing of copper parts. I work with customers on brazing applications and conduct braze training courses. I chair the American Welding Society A5H subcommittee on Brazing Filler Metals and Fluxes. I am also an American Welding Society Certified Welding Inspector.

I have reviewed the PL 149319 reference. Under my direction, alloys A-K, as set forth in the table below, were made into powders at my direction.

Alloy	P	Sn	Si	Ni	Ag	Sb	Cu
A	0.1	25	0.5	0.1	15	0.1	Balance
B	1	6	0.5	0.1	15	0.1	Balance
C-1	3	6	0.5	0.1	15	0.1	Balance
C-2	3	6	0.5	0.1	0	0.1	Balance
D-1	6	11	0.5	0.1	15	0.1	Balance
D-2	6	11	0.5	0.1	0	0.1	Balance
E	6	4	0.5	0.1	15	5	Balance
F	6	8	0.5	0.1	15	3	Balance
G	11	9	0.5	0.1	15	5	Balance
H-1	11	6	0.5	0.1	15	0.1	Balance
H-2	11	6	0.5	0.1	0	0.1	Balance

I	4	8	0.5	0	0	0	Balance
J	10	1	0.5	0	0	0	Balance
K	6.7	6.65	0.15	0	0	0	Balance

The powders had about a 50 mesh size, which corresponds to a majority of particles being below 297 μm. Alloy A corresponds exactly to the example set forth in the second-to-last line of the Polish Abstract, but falls outside the claimed ranges in the present application. Alloys B through H-2 all fall within the broad range disclosed in the second sentence of the Polish Abstract, mainly with the phosphorus and tin contents varied from that of Alloy A, but each falls outside the claimed ranges in the present application. Alloys I-K fall within the broad range disclosed in the second sentence of the Polish Abstract, and fall within the claimed ranges in the present application.

Upon my further direction, Lynda Morgan formed a carrier containing 80% water, 18% glucose and 2% methyl cellulose, in accordance with the specific example provided in the last sentence of the Polish Abstract, and then mixed this carrier with each of Alloy Powders A through K so as to provide a paste containing 80% of the alloy powder and 20% of the carrier, which is indicated by the Polish Abstract as being typical for a brazing paste.

I attempted to braze copper coupons and/or T-Joints using the brazing paste as taught by the Polish Abstract. I was unable to get the paste to properly melt and flow. Attached to my Affidavit are several pictures illustrating the inability to properly melt and flow the braze paste.

1. The first picture is entitled "T-Joint — Paste A, No Flux, After Braze Test." There was some melting and flowing, but large globs of paste remained, and a smooth fillet could not be obtained. In addition, we were unable to melt and flow the braze paste at temperatures below 1292°F. When the alloy did start to melt, a pyrometer (Fluke Instruments 50S) was used to measure the heat applied to the paste. In the first test run, the temperature reading was 1524°F; and in the second test run, the temperature reading was 1536°F. Due to using a handheld pyrometer, the measurement had to be taken away from the actual braze, so the temperature readings are understated from what the actual reading would be at the alloy melt location. Thus, temperatures well in excess of 1500°F were needed to get the paste to begin to melt and flow.

2. The second picture is "T-Joint — Paste B, No Flux, During Heating." The third picture is entitled "T-Joint — PasteB, No Flux, Heated State." The fourth picture is "T-Joint — Paste B, No Flux, After Braze Test." The second picture shows the paste at a copper T-joint during the heating process, while the second picture shows the heated T-joint after the heat is removed, but still in the red-hot heated state. As shown in both those pictures, the paste simply formed globules and did not melt and flow into the joint

to form a braze. The third picture further shows the copper T-joint having a bright red color, which indicates a very high heat was put into the part to attempt to melt the paste, and even then, melting did not occur to form a braze. The fourth picture shows what happened when we continued to heat the paste to attempt to get it to melt and flow. The paste still didn't melt and flow, and eventually, the copper base metal melted instead.

3. The Polish Abstract stated that the brazing could be performed below 973 K, which corresponds to 1292°F, but I was not able to obtain a braze either below that temperature, or at temperatures well above that temperature. The first four pictures attached specifically show the attempt to braze a paste using Alloys A and B. I also attempted several other of the Alloys A-K, and obtained essentially identical results with each attempt, namely, the pastes either simply would not melt and flow, or when they did flow, it required excessive heat well above 1292°F.

4. Thus, I attempted to follow the teachings of the Polish Abstract, both in its broad teachings and its specific example, and I was unable to form a braze using a brazing paste as taught therein.

The Polish Abstract does not suggest that a flux must be used in addition to the carrier, and as one skilled in the art, I would read the reference to imply that the carrier is used instead of a flux. Nonetheless, I attempted to form a braze by adding a standard commercial brazing flux in an amount of 1 gram of flux per 3 grams of powder/carrier paste. Attached to this Affidavit is a fifth picture entitled "Paste with Flux on Coupon" which shows a paste formed from Alloy Powder C-1 and the carrier, and then mixed with the flux and brazed onto a copper coupon. The braze is very bumpy, showing that the powder still does not melt completely nor flow properly, even in the presence of a flux, and heat damage occurred to the coupon, as indicated by the purple colored ring around the braze. While a braze could theoretically be obtained from this paste using a commercial flux, the braze would not be acceptable due to the number of particles that did not melt and remain as solid particles within the braze, and due to heat damage to the part.

Sixth and Seventh pictures entitled "T-Joint – Paste E, Before Braze Test" and "T-Joint – Paste E, With Flux, After Braze Test" are also attached. The sixth picture shows the paste of Alloy E on a clean copper T-joint with no flux added, prior to brazing. The commercial flux was then added at a 3:1 ratio and a braze joint formed, as shown in the seventh picture. The braze did enter the capillary, although it took a long period with high heat to get the paste to flow. A significant amount of black oxide formation occurred, as can be seen in the photograph. Thus, while the addition of a flux permitted a braze to be formed, the braze would not be

commercially suitable.

Thus, I carried out experiments in an attempt to duplicate the teachings of the Polish Abstract, which were to combine an alloy powder with a methyl cellulose/glucose/water carrier to form a paste, and to braze the paste to copper components at a temperature below 1292°F. Following these teachings, I was unable to form any brazed joints because I could not get the paste to melt and flow at temperatures below or above 1292°F. As one skilled in the art, the Polish Abstract suggests to me that a flux need not be used due to the presence of the carrier. However, the only possible way to form a brazed joint from the brazing paste was to use a known commercial flux, and even then, a commercially suitable brazed joint could not be obtained.

Further declarant sayeth naught.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

IN WITNESS WHEREOF, I hereto set my hand and seal at

Warren County, Ohio

this 31st day of August, 2005.

Robert Henson

Robert Henson

STATE OF OHIO:

:ss.

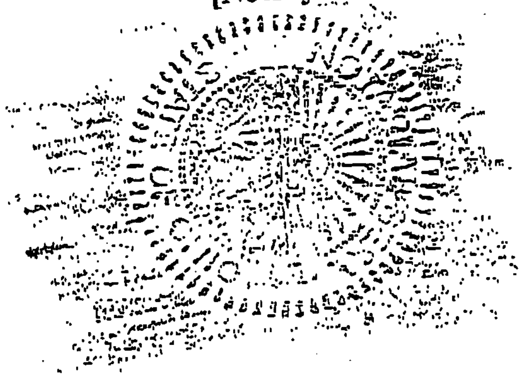
COUNTY OF WARREN;

Before me 31st day of August, 2005, personally appeared Robert Henson, known to me to be the person whose name is subscribed to the foregoing and acknowledged that he executed the same as his free act and deed for the purposes therein contained.

Rosemary L. Wiley Notary Public

My Commission Expires:

[Notary's Seal Here]



ROSEMARY L. WILEY
Notary Public, State of Ohio
My Commission Expires Oct. 23, 2005

OCT 23, 2005

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SECOND AFFIDAVIT OF ROBERT HENSON UNDER 37 C.F.R. § 1.132, ¶ 1

(1) My name is Robert Henson. I am the Technical Director of the J.W. Harris Co., and have held that position for the last ten years. I have been employed by J.W. Harris Co. for a total of twenty-seven years. In my current and past capacities with J.W. Harris Co., I have had extensive experience with brazing alloy compositions, various forms of brazing components, the use of brazing fluxes, and the brazing of copper parts. I work with customers on brazing applications and conduct braze training courses. I chair the American Welding Society A5H subcommittee on Brazing Filler Metals and Fluxes. I am also an American Welding Society Certified Welding Inspector.

(2) I have reviewed the PL 149319 reference. Under my direction, alloys A-K, as set forth in the Table 1, attached hereto, were melt and cast into billets at my direction. A charge card, which is a list of components used to charge the furnace, was prepared for each melt, including the materials charged in, and final charge component percentages. Cooling curves were also made to establish the liquidus and solidus temperatures, as well as any thermal arrests. The charge cards and cooling curves are attached in the Exhibit, which includes sections labeled ALLOY A through ALLOY K. The numerical values for the temperatures are also provided in Table 1.

(3) Alloy A corresponds exactly to the example set forth in the second-to-last line of the Polish Abstract, but falls outside the claimed ranges in the present application. Alloys B through H-2 all fall within the broad range disclosed in the second sentence of the Polish Abstract, mainly with the phosphorus and tin contents varied from that of Alloy A, but each falls outside the claimed ranges in the present application. Explanations for each alloy are provided in the "Comments" column in Table 1. Alloys I-K fall within the broad range disclosed in the

second sentence of the Polish Abstract, and fall within the claimed ranges in the present application.

(4) For each alloy, at my direction, we attempted to extrude the billets into rod (wire) using a production extrusion press. The results for each alloy are also set forth in the Exhibit within each section, on a page entitled "R & D RUN," including comments and pictures, where possible, for each alloy. Commercial BCuP alloys generally extrude at speeds of 20-25 FPM. From a production cost standpoint, if a solid brazing component cannot be produced from the alloy efficiently, then the alloy will not be suitable as a commercial brazing alloy. If the wire "hot shorts", that means it breaks into pieces. If the alloy cannot be extruded without hot shorting, then the alloy is not capable of being fabricated into one of the solid component forms that are claimed in the present application. After the alloys are extruded, the rod or wire is wrapped onto a reel for storage and shipping. If the wire is too brittle, it cannot be wrapped onto the reel, and will likely not be capable of forming a braze without cracks, and thus, is not suitable as a wire brazing component.

(5) At my direction, the rods extruded per the above data were braze tested, without the use of a flux. While known commercial fluxes may be used, for example a flux-cored wire, phosphorus-copper brazing alloys, as a class defined by the American Welding Society, are generally considered to be self-fluxing in that they are capable of being brazed without the use of a flux. These phosphorus-copper alloys are primarily designed to braze copper, so we tested each with several copper parts. We first brazed a copper "T" shaped joint to evaluate capillary flow. We then brazed a copper tube to a coupling and a "return bend". Both of these are common brazed assemblies. For several of the compositions, we also included a Bend Test. Many compositions will produce a braze in some type of connection, although not necessarily a reliable, sound braze. Most important, however, is if the brazed part exhibits suitable strength or ductility for service. A common use for these products is in brazing cooling and refrigeration connections. These applications are subject to high vibration and temperature cycling, and thus, the braze must be capable of withstanding the conditions without cracking and ultimately failing.

(6) For Alloy A, we also sectioned the tube joint to see what type of capillary penetration occurred. A sound brazed connection depends on filler metal flow into the capillary. If the alloy does not penetrate, the joint will often fail in service.

(7) Results for the brazing tests are discussed below, and color pictures of the test samples are provided in the Exhibit, within the respective section for each alloy. Also provided, is a summary of the alloy, its temperature characteristics, and its potential suitability as a commercial wire or rod brazing alloy.

ALLOY - A

T Joint – Sluggish flow. Seemed to run and stop. This is likely due to low phosphorus content.

Tube – Can "cap" but there is rough appearance and poor flow.

Return bend – No sample done

Bend Test – Many surface cracks

Tube Section Test – No braze penetration.

Comments: While the alloy was extruded into rod form for experimental purposes, based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to a run speed that is well below that of commercial BCuP alloys, the high potential for hot shorting, and brittleness. Because of the extremely low phosphorus content, this alloy would not likely be considered a BCuP alloy, and brazing cannot be accomplished without the use of a flux. The alloy had poor flow, and did not penetrate the capillary. Standard commercial brazing filler metals, as well as Alloy K, typically produce 70% minimum linear penetration. The braze lacks strength and ductility, as indicated by the extensive cracking from the bend test, which is consistent with the brittleness exhibited by the alloy during extrusion.

ALLOY - B

T Joint – Sluggish flow. Seems to have high surface tension, or the low phosphorus content reduces wetting.

Tube – Slow flow. Seems to be some liquation of lower melting constituents. Required frequent rod additions to fill joint.

Return Bend – Required high heat and had to add rod frequently around the joint to fill.

Comments: While the alloy was extruded into rod for experimental purposes, based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to a very slow run speed (well below commercial BCuP alloys) and the high potential for hot shorting. The alloy has a very wide brazing temperature range (1045°F-1669°F), no major thermal arrest, and very high liquidus temperature. Therefore, the brazing temperature for this alloy is prohibitively high, being at or near 1669°F. In addition, because of the low phosphorus content,

this alloy is not considered a BCuP alloy, and brazing cannot be accomplished without the use of a flux. The alloy had poor flow, did not melt completely (the alloy liquated, meaning that it separated, with some constituents melting and others remaining solid), and required repeated additions to fill the joints. This alloy would not be suitable for commercial brazing in wire or rod form.

ALLOY – C-1

T Joint – Reasonable flow.

Tube – Suitable flow around joint. Higher phosphorus content helped flow.

Return Bend – Required fairly high heat to fill and cap.

Comments: The liquidus temperature is still high for this alloy, although the increase in phosphorus did lower that temperature, and a major thermal arrest is observed. This alloy was hard to extrude, and based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to the very slow run speed (well below commercial BCuP alloys) and high potential for hot shorting. An improvement in the ability to flow was observed, but the amount of heat required to fill the joint and form a cap is still prohibitive.

ALLOY – C-2

T Joint – Liquated heavily, requires close heat monitoring to ensure sufficient preheat to prevent this.

Tube -- Requires high heat. Caps, but appears there is limited penetration.

Return Bend – Caps, but requires high heat. We suspect there is limited penetration.

Comments: Compared to Alloy C-1, the absence of silver in this alloy results in a very high liquidus temperature, although a major thermal arrest is still observed. This alloy was hard to extrude, and based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to the very slow run speed (well below commercial BCuP alloys) and high potential for hot shorting. The heavy liquation of the alloy and necessity for close monitoring makes it impractical for use. More importantly, the lack of penetration into the joints means that the braze will have a high likelihood of failure in service, and thus is not a reliable braze material.

ALLOY – D-1

T Joint – Very fast flow as expected with high Sn, P, and Ag content.

Tube -- Flows quickly, doesn't fill wide gaps, leaves voids, and is difficult to cap.

Return bend – Difficult to fill the gap at the flare.

Bend Test – Cracks in braze.

Comments: Good temperature profile, but the alloy was hard to extrude, and based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to the slow run speed (well below commercial BCuP alloys) and high potential for hot shorting. In addition, the wire was extremely brittle, and could not be wrapped onto a reel. During the braze tests, the alloy flowed too quickly, such that gaps could not be filled and voids were left in the brazed joints of the tube and return bend. These brazed parts would be scrapped upon visual inspection. In addition, the braze cracked in the bend test, such that if the parts were not scrapped, there is a high likelihood of failure in service. Thus this alloy is not a reliable braze material.

ALLOY – D-2

T Joint – Flows quickly – good capillary flow.

Tube – Good flow, somewhat hard to build cap and bridge gaps.

Return bend – Caps OK but have to add rod at many spots to fill.

Bend Test – Cracks in braze.

Comments: Good temperature profile, but the alloy was hard to extrude, and based upon my experience, it would not be practical to extrude this alloy on a commercial basis. In addition, the wire was extremely brittle, and could not be wrapped onto a reel. During the braze tests, the alloy flowed too quickly, such that gaps could not be easily filled and voids were left in the brazed joints of the tube and return bend. These brazed parts would be scrapped upon visual inspection. In addition, the braze cracked in the bend test, such that if the parts were not scrapped, there is a high likelihood of failure in service. Thus, this alloy is not a reliable braze material.

ALLOY - E

T Joint – Free flowing, good capillary.

Tube – Flows quickly, difficult to bridge gaps and make cap.

Bend Test - OK

Comments: Good temperature profile, but the alloy was hard to extrude, and based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to the very slow run speed (well below commercial BCuP alloys) and high potential for hot shorting. During the braze tests, the alloy flowed too quickly, such that gaps could not be easily filled and a raised cap did not form. Thus, this alloy is not a reliable braze material.

ALLOY - F

T Joint – Flows OK, but appears to be surface "dross," which refers to surface scum that forms as a result of oxidation.

Tube -- Marginal flow and capping ability – tends to quickly follow heat down the side of the coupling.

Return Bend - OK flow and cap.

Bend Test – Many cracks across braze.

Comments: OK temperature profile, but alloy could not be extruded into wire or rod form. The extruder was repeatedly plugged by the material and hot shorting was extreme. Dross was observed, which is unacceptable for a commercial brazing alloy, and the braze cracked in the bend test, such that there is a high likelihood of failure in service. Thus, this alloy is not a reliable braze material.

ALLOY - G

Comments: The alloy could not be extruded into rod or wire form. The high phosphorus, tin and antimony contents proved to be disastrous. The alloy had a very high liquidus and the solidus could not be identified. Braze tests using a solid braze component could not be performed.

ALLOY – H-1

Comments: The alloy could not be extruded into rod or wire form. Lowering the tin and antimony content did not help--the high phosphorus content proved to be disastrous. The alloy had an even higher liquidus and the solidus only appeared to be identified. Alloy has a very wide brazing temperature range (1069°F-1620°F), and no major thermal arrest. Therefore, the brazing temperature for this alloy is prohibitively high, being at or near 1620°F.Braze tests using a solid braze component could not be performed.

ALLOY – H-2

T Joint – Quick flow.

Tube – Flows OK, but can't cap without a second pass.

Coupon # 1- Rough bead on plate – appears to be "dross".

Bend Test – Cracks in braze.

Comments: Without the silver addition, the liquidus temperature is even higher for this alloy, although a major thermal arrest is observed. While the alloy was extruded into rod for experimental purposes, based upon my experience, it would not be practical to extrude this alloy on a commercial basis due to very slow run speed (well below commercial BCuP alloys) and poor heating of the billet. The alloy is very brittle after extrusion, and breaks into pieces when hand bent. Surface dross is observed, and the braze cannot be formed with a raised cap, even after a second pass. More importantly, the braze cracks in the bend test, which is consistent with it's brittle nature after extrusion, and thus, this brazing alloy would have a high likelihood of failure during service. Thus, this alloy is not a reliable braze material.

ALLOY – I (Alloy of Invention)

T Joint – Good capillary flow.

Tube – Good flow and cap.

Return Bend – OK, good cap.

Bend Test – Good, only small, slight crack.

Comments: The liquidius temperature is a bit high due to the phosphorus content being at the lower end of the desired range, but a thermal arrest is observed. The alloy was able to be extruded into rod form with good flow properties and acceptable run speed, although the resulting rod/wire was brittle. Additional experimentation, including working the wire, may improve the ductility. The braze tests showed good braze performance, including good flow and cap formation. Only a slight, small crack was observed in the bend test. This alloy could potentially be used commercially, if the brittleness after extrusion can be improved, but the run speed may be limited to the lower end of speeds considered suitable for production.

ALLOY – J (Alloy of Invention)

T Joint – Good capillary flow.

Tube -- Good flow, slightly less capping ability due to higher phosphorus.

Bend test – One crack.

Comments: The brazing temperature range, although narrow, is on the high end for this alloy, demonstrating the effect of having phosphorus near the upper end of the claimed range, and tin at the lower end. An improvement in the temperature profile could be obtained by using 9% or less phosphorus and/or using more tin. The rod/wire was also very brittle after extrusion, although a high run speed was possible. During braze testing, the alloy flowed well, but the high phosphorus content limits the capping ability and contributed to a crack forming during the bend test. Again, an improvement would be expected with a lower phosphorus content.

ALLOY – K (Alloy of Invention)

T Joint – Good flow.

Tube -- Good flow and capping ability.

Bend Test – No cracks.

Comments: Good temperature profile—narrow brazing temperature range and low liquidus temperature. Fast run speeds during extrusion and wire was not brittle. During braze tests, the alloy flowed well, formed good caps and smooth brazes, had good penetration, and the braze did not crack during the bend test. Capable of being commercially produced, and no evidence of likelihood of failure in service.

SUMMARY:

Most of the Alloys A through H-2 can produce brazed joints. The melting characteristics and deposit characteristics, however, are unsuitable for commercial production brazing based upon my experience. Either cost would be very high due to poor extrusion/drawing characteristics, or flow is either too sluggish or too fluid. Some of the Alloys could not be extruded into wire form. Further, some of the brazed joints do not exhibit the necessary ductility to produce braze assemblies subject to stress or vibration, and some of the joints have voids therein and limited penetration thus making them susceptible to service failures. In addition, the temperature profiles for several the Alloys were unacceptable.

(8) From my experiments, I have shown that the temperature characteristics for phos-copper brazing alloys can vary widely with composition, such that a low and narrow brazing temperature range is not inherent in the broad composition ranges disclosed in the Polish Abstract. To produce brazing alloys that are suitable for commercial use, it is necessary to understand the interaction between the various elements in the alloy, and the effect that too much or too little of an element can have on the fabrication and brazing characteristics of the alloy. The Polish Abstract discloses a broad phosphorus range with no appreciation of the negative effect of too little or too much phosphorus. In fact, the example provided in the Polish Abstract would not likely qualify for inclusion as a phos-copper braze alloy by the American Welding Society. In addition, the Polish Abstract does not appreciate the limits that the inventor of the present application discovered with respect to the limitation on tin and antimony content.

RMH
(8)(2) It is my opinion that the Polish Abstract does not teach one skilled in the art how to produce a suitable solid brazing component. It is further my opinion that a powder metal is not understood by one skilled in the art to be a solid brazing component, as that term is commonly understood.

Further declarant sayeth naught.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

IN WITNESS WHEREOF, I hereto set my hand and seal at Warren County, Ohio,
this 31st day of August, 2005.

Robert Henson

STATE OF OHIO:
:SS.
COUNTY OF WARREN;

Before me 31st day of August, 2005, personally appeared Robert Henson, known to me to be the person whose name is subscribed to the foregoing and acknowledged that he executed the same as his free act and deed for the purposes therein contained.

Notary Public

My Commission Expires: 23 OCT 2005

ROSEMARY L. WILEY
Notary Public, State of Ohio
My Commission Expires Oct. 23, 2005

[Notary's Seal Here]

TABLE 1

Alloy	P	Sn	Si	Ni	Ag	Sb	Cu	Liquidus T	Major Thermal Arrest	Solidus T	Comments
A	0.1	25	0.5	0.1	15	0.1	Balance	1284	None	1040	Identical to example in Polish Abstract
B	1	6	0.5	0.1	15	0.1	Balance	1669	None	1045	Within Polish ranges; P content below claimed range
C-1	3	6	0.5	0.1	15	0.1	Balance	1464	1130	1046	Within Polish ranges; P content just below claimed range
C-2	3	6	0.5	0.1	0	0.1	Balance	1671	1225	1160	Within Polish ranges, but no Ag; P content just below claimed range
D-1	6	11	0.5	0.1	15	0.1	Balance	1305	1106	1046	Within Polish ranges; P within claimed range, but Sn just above claimed range
D-2	6	11	0.5	0.1	0	0.1	Balance	1293	1199	1177	Within Polish ranges, but no Ag; P within claimed range, but Sn just above claimed range
E	6	4	0.5	0.1	15	5	Balance	1215	None	1165	Within Polish ranges; High Sb content—above claimed range
F	6	8	0.5	0.1	15	3	Balance	1352	None	1091	Within Polish ranges; Sb + Sn > 10%—above claimed range
G	11	9	0.5	0.1	15	5	Balance	1584	None	??	Within Polish ranges; P, Sb, Sn+Sb above claimed range
H-1	11	6	0.5	0.1	15	0.1	Balance	1620	None	1069	Within Polish ranges; P above claimed range, Sn within range (opposite D-1)
H-2	11	6	0.5	0.1	0	0.1	Balance	1677	1164	1037	Within Polish ranges, but no Ag; P above claimed range, Sn within range (opposite D-2)
I	4	8	0.5	0	0	0	Balance	1467	1227	1179	Within claimed range: Near lower limit of P and upper limit for Sn for claimed range: Results for invention near endpoints
J	10	1	0.5	0	0	0	Balance	1503	None	1308	Within claimed range: Near upper limit of P, lower limit for Sn for claimed range: Results for invention near endpoints
K	6.7	6.65	0.15	0	0	0	Balance	1256	None	1179	Within claimed range: Exemplary embodiment